Preface

Low impact development (LID) is a stormwater management strategy that emphasizes conservation and use of existing natural site features integrated with distributed, small-scale stormwater controls to more closely mimic natural hydrologic patterns in residential, commercial, and industrial settings.

Many of the tools used for LID are not new. Village Homes in Davis, California, constructed in the early 1970s, is perhaps the earliest recognized example of a residential subdivision that manages stormwater through open conveyance systems and provides storm flow retention in open space integrated throughout the development. During the early 1980's European cities began using distributed, integrated stormwater management practices to reduce flows from combined sewer systems. In the late 1980's, Larry Coffman with the Department of Environmental Resources in Prince George's County, Maryland began working on a plant, soil-microbe filter designed to mimic natural forest hydrologic characteristics (bioretention, or rain gardens). Today LID strategies are an integral part of Prince George's County's stormwater management approach and numerous developments across the U.S., Canada, and Europe include LID practices.

In Puget Sound, state and local government agencies and university extension programs have offered and continue to offer numerous workshops, conferences, and courses for engineers, planners, architects, and elected officials. These focus on the problems associated with stormwater runoff, the limitations of conventional management practices, and the LID approach to protect ground and surface waters. As a result of these efforts, several local governments and state agencies are incorporating LID techniques into their stormwater manuals, development regulations, and regional guidance. Many of the organizations are using LID techniques in commercial, residential, and municipal projects. The most active of these organizations include: the cities of Seattle, Olympia, and Bellingham; King, Snohomish, and Pierce counties; Washington departments of Ecology and Transportation; and the Puget Sound Action Team (Action Team).

Initial findings from limited monitoring in Puget Sound and other studies from the U.S., Europe, Canada, and Japan indicate that LID practices can be valuable tools to reduce the adverse effects of stormwater runoff on streams, lakes, wetlands, and Puget Sound. However, important questions remain regarding relative cost, design, maintenance, and long-term performance. To answer these questions and better understand the full potential and limitations of LID in the Puget Sound region, additional research and monitoring of individual LID techniques and pilot projects are needed.

Demonstration projects and monitoring are needed to understand the long-term performance and maintenance requirements of bioretention swales and cells, permeable paving, and other LID practices in difficult (and common) Puget Sound settings, such as native soils with low infiltration rates and higher urban densities. Pilot projects will also provide data comparing LID construction costs and market performance to conventional development and stormwater management strategies.

While uncertainties regarding LID exist, current data and the need for additional tools to manage stormwater runoff warrant initiating the next steps: (1) implement and

monitor demonstration projects; (2) develop regulatory guidance for LID practices; and (3) remove local regulatory barriers that discourage use of LID strategies.

New stormwater management tools are needed to address a number of critical environmental issues facing Puget Sound. Chinook and chum salmon and bull trout are listed as threatened under the federal Endangered Species Act, and scientists have cited loss of habitat due to development and stormwater runoff as one factor that has contributed to their population declines. The Washington Department of Ecology (Ecology) estimates that about one-third of all polluted waters on the section 303(d) list are degraded because of stormwater runoff. Puget Sound is one of the best regions in the world to grow clams, oysters, and other shellfish, yet thousands of acres of shellfish growing areas are closed to harvest due to stormwater runoff and other pollutant sources. Finally, more than 70 smaller local governments in Puget Sound will soon be required to comply with a federally mandated stormwater permit under the National Pollutant Discharge Elimination System Program. Newly permitted local governments will be seeking stormwater management techniques that help them comply with permit conditions and protect surface waters in an efficient, cost-effective manner.

To better address these issues, two state offices have taken significant steps related to LID. Ecology, collaborating with local government stormwater managers and Washington State University, has completed initial guidelines for flow reduction credits when LID techniques are used in projects in western Washington. The credits, included in Ecology's 2005 *Stormwater Management Manual for Western Washington* and in Chapter 7 of this manual, will provide designers with additional tools to retain stormwater on-site and reduce the size of conventional facilities that control storm flows. The Action Team, the broad partnership to conserve and recover Puget Sound, has identified LID as a priority action for the 2001-03, 2003-05, and now the 2005-07 biennial work plans to the Washington State Legislature. This emphasis has produced a national conference, regional workshops, local technical and financial assistance, and special projects, including development of this technical guidance manual. The *Puget Sound Water Quality Management Plan*, the state and federal plan to protect and restore Puget Sound, also calls on all local governments in Puget Sound to adopt new or revise existing ordinances to allow and encourage LID techniques.

Purpose of this Manual

The purpose of this manual is to provide stormwater managers and site designers with a common understanding of LID goals, objectives, specifications for individual practices, and flow reduction credits that are applicable to the Puget Sound region.

In addition to the guidelines for specific practices, this manual provides research and data related to those practices to help managers and designers make informed decisions when adapting LID applications to their jurisdictions. Low impact development is a new and evolving management approach; accordingly, this document will evolve and be periodically updated as additional research becomes available and professionals in the region gain more practical experience. This is a technical manual and the information provided is targeted for engineers, planners, landscape architects, technical staff to policy makers, and developers.

How this Manual is Organized

Chapter one of the manual sets the context for the LID approach with an introduction to Puget Sound lowland hydrology and the effects of urban development on streams, wetlands, and Puget Sound. Chapter one also establishes the goals and objectives for LID. Chapters on site assessment, planning and layout, vegetation protection, and clearing and grading follow, and emphasize the importance of planning and protecting native vegetation and soils in the LID approach. Chapter six provides general guidance for six integrated management practices (IMPs), as well as detailed construction and material specifications for many of the IMPs. Chapter seven provides the new credits in the Western Washington Hydrology Model that will allow engineers to reduce the size of conventional flow control facilities when using LID practices. Finally, several appendices include sample specifications, lists of plants appropriate for LID applications, and tables summarizing bioretention and permeable paving research. Bolded words within the text of the manual are defined in the glossary of terms.

Low Impact Development Applications

The LID approach can be applied in a variety of settings including: large lots in rural areas; low, medium, and high-density development within urban growth boundaries; redevelopment of highly urbanized areas; and commercial and industrial development. LID applications can be designed for use on glacial outwash and alluvium soils, as well as soils with low infiltration rates, such as dense silt loams or till mantled areas.